

METEOROLOGICAL DECISION AID DEVELOPMENT AND VALIDATION FOR NAVAL AVIATION

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1. INTRODUCTION

Support of Naval aviation, with a primary emphasis on flight safety and efficiency, has always been a priority of the environmental community within the Navy (Brand and Dreksler, 1995). The Naval Research Laboratory (NRL) Marine Meteorology Division has been involved in the development of several meteorological decision aids (MDAs) to enhance this support. Aviation impact variables (AIVs), such as cloud ceiling, visibility, flight conditions (IFR - Instrument Flight Rules, MVFR - Marginal Visual Flight Rules, VFR - Visual Flight Rules), and aircraft icing have been the focus of the decision aid development efforts thus far.

These decision aids are designed to provide both environmental forecasters and aviators with state-of-the-art graphical displays of AIVs. The primary users of these decision aids will be the Naval Meteorology and Oceanography (METOC) Facilities and Detachments providing aviation weather forecast support ashore and the METOC component onboard major combatant ships that provide this support afloat. The Joint METOC Viewer (JMV), a viewer application developed by the Space and Naval Warfare Systems Command (SPAWAR) along with the Fleet Numerical Meteorology and Oceanography Center (FNMOC), has been the target application for transition of the decision aids (Ravid et al., 1997). JMV has been designed to provide users with a "quick-look" of the environment to evaluate its impact on mission planning and execution.

In addition to the meteorological decision aid development, NRL is also involved in evaluating the accuracy of AIVs derived from the Navy Operational Global Atmospheric Prediction System (NOGAPS) (Hogan et al., 1991). Several algorithms, used in conjunction with NOGAPS model output, have been evaluated for their skill in forecasting derived AIVs such as aircraft icing and clear-air turbulence. Also, sensible weather parameters, such as cloud amount, ceiling, top, type, and fog, derived from model output, have also been evaluated.

2. METEOROLOGICAL DECISION AID (MDA) DEVELOPMENT

Decision aid development at NRL has been divided into two general categories based on the data source. The first category includes displays derived exclusively from aviation text bulletins and the second category includes those derived from numerical weather prediction systems.

The first MDA developed was a simple visual display of METAR surface observations. For a specific geographic area, users are presented with a map background overlaid with symbols indicating the location of current observations. Running a mouse over a particular

symbol reveals the station ID and mouse clicking on the symbol opens a window that displays a formatted and raw version of the original report. Several enhancements have already been made to this display that allow users to select individual or combinations of reported parameters, set thresholds on those parameters, and choose the colors in which to display those parameters. For example, a very useful combination is constructed by setting all stations reporting IFR conditions, that is, ceilings below 1000 feet and/or visibility less than 3 miles, to display in red. Similarly, those stations reporting VFR or MVFR conditions are set to green and yellow, respectively. This MDA is a vast improvement over text-based displays in that it provides both forecasters and aviators with the ability to instantly evaluate current flight conditions over a large geographic area.

The second MDA developed was a visual display of Convective SIGMETs (Significant Meteorological Information). Like the METAR product, this MDA is produced by decoding warning information contained in the text bulletin and overlaying the corresponding warning polygon on a map background. This product is effective in giving forecasters and pilots a "quick-look" at reported hazardous flying conditions in the area of interest. Planned enhancements to this MDA will include other types of aviation warnings such as non-convective SIGMETs, Airman's Meteorological Information (AIRMETs) warnings, Weather Watches (WWs) and Pilot reports (PIREPS).

The third MDA developed was a visual display of Terminal Aerodrome Forecasts (TAFs). Typically, TAFs are co-located with METAR reports. Therefore, when both reports are available for a specific station, a unique symbol is used to indicate station position. When a station with both reports is mouse-clicked a window opens to display both the current METAR report and the current TAF. A significant enhancement underway for this MDA is the ability to modify the display based on a particular forecast parameter or combinations of forecast parameters at a user specified time in the future. For example, for a collection of TAFs valid from 00-24Z, a user could at 03Z, set the MDA to display flight conditions, IFR, MVFR, VFR for all reporting stations at 12Z. We believe this product will be extremely useful for aviators during flight planning by providing them with an easily understood tool to determine forecast conditions at multiple terminals simultaneously.

As mentioned previously, also being developed are a second category of MDAs derived from state of the atmosphere variables produced by numerical models. An aircraft icing decision aid based on the Shultz-Politovich (Schultz and Politovich, 1992) icing algorithm developed at the National Center for Atmospheric Research (NCAR) is currently under development. This MDA will use 6-hour forecasts of temperature and relative humidity from the NOGAPS model and will provide forecasters and aviators with short-range forecasts of icing potential at several levels in the atmosphere.

A second model-derived MDA, based on the Coupled Ocean Atmospheric Mesoscale Prediction System (COAMPS) (Hodur, 1993) is also under development. This product will use 3-hour COAMPS forecasts of cloud droplets to construct a cloud-top temperature field. This cloud-top temperature field is then colored in gray-shades to match temperatures from infrared satellite images. This product is expected to be very useful to forecasters and aviators in determining areas expected to be influenced by clouds.

3. VERIFICATION STUDIES

Three verification studies to determine the accuracy of AIVs derived from numerical prediction systems have been completed at NRL Monterey. Vogel and Sampson, 1996

evaluated turbulence indices using model output from NOGAPS. Vogel, 1997 documented a verification study of aircraft icing potential using four aircraft icing algorithms computed from NOGAPS model data. More recently, a study to evaluate NOGAPS skill in the short-range (0-24 hours) forecasting of cloud amount, ceiling, top, type, and fog has also just been completed (Vogel 1998). The forecasts were verified against METAR surface observations and pilot reports. Results show NOGAPS forecasts of significant cloud cover, indicated by a broken or overcast layer, and no cloud cover were fairly reliable. NOGAPS forecasts of cloud ceiling were less reliable, with only 1 in 5 forecast ceilings within 500 feet of observed ceilings. Cloud ceiling forecasts were generally below what was observed. Cloud tops were consistently forecast to be higher than observed, with 2 of 3 model cloud tops forecast within 4000 feet of observed cloud tops. NOGAPS predictions of cloud type, both stable and convective were good in the lowest atmospheric layer and forecast capability for cumulo nimbus/towering cumulus were better than for cumulus. NOGAPS fog algorithm showed only modest skill in forecasting fog with better skill in the Gulf of Mexico, Great Lakes and Atlantic than the Pacific coast.

4. SUMMARY

NRL Monterey has completed several verification studies involving aviation impact variables including clear-air turbulence, aircraft icing, and cloud amount/ceiling/top/type and fog. All studies thus far have involved the use of NOGAPS model output. In doing so, baseline criteria have effectively been established for the skill of NOGAPS in the short-range forecasting of these AIVs. As improvements in numerical modeling and AIV algorithm development are realized, the effectiveness on the improvement of AIV forecasting can be readily analyzed by comparisons to this baseline. In addition, comparative evaluations could be made with higher resolution mesoscale models such as COAMPS.

In addition to the verification studies, several MDAs have been developed or are under development. Initial development has concentrated on converting text-based aviation-related messages into graphical displays. These displays are effective in presenting large amounts of data in a single image and also provide users with tools to modify the display to suit their particular needs. Aircraft icing potential and cloud decision aids derived from model output are also being developed to provide users with short-range forecasts of these important AIVs. These MDAs will provide Naval forecasters and aviators with effective tools to evaluate the atmosphere's impact on mission planning and execution.

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